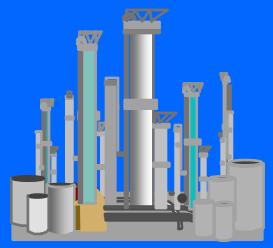
Welding Terms

--- and other strange nomenclature



Welding

A joining process that produces a coalescence of metals (or non-metals) by heating them to the welding temperature,

- with or without the application of pressure, or by pressure alone, and
- with or without the use of filler metals

Process

A method of performing welding, such as:

- shielded metal arc welding
- submerged arc welding
- gas metal arc welding
- gas tungsten arc welding
- oxyacetylene welding

Procedure

A way of performing or effecting something; a course of action.

WPS-Welding Procedure Specification

A document providing in detail the required variables for specific application to assure repeatability by properly trained welders

Shielded Metal Arc Welding (SMAW)

An arc welding process that produces a coalescence of metals by heating with an arc between a covered metal electrode and the work pieces.

"Stick" Welding

-continued-

Shielded Metal Arc Welding (SMAW)

- Shielding is obtained from decomposition of the electrode covering.

- Filler metal is obtained from the electrode.

Submerged Arc Welding (SAW)

An arc welding process that uses an arc between a bare metal electrode and the weld pool. The arc and molten metal are shielded by a blanket of granular flux.

Gas Metal Arc Welding (GMAW)

An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal (consumable) electrode and the work.

"MIG" welding

Gas Metal Arc Welding (GMAW)

Shielding is obtained entirely from an externally supplied gas or gas mixture.

Gas Tungsten Arc Welding (GTAW)

An arc welding process that produces coalescence of metals by heating them with an arc between a tungsten (non-consumable) electrode and the work piece.

"TIG" welding

-continued-

Gas Tungsten Arc Welding (GTAW)

Shielding is obtained from an externally supplied gas or gas mixture.

Oxyacetylene Welding (OAW)

An oxy-fuel gas welding process that uses acetylene as the fuel gas.

Base metal

The metal to be welded or cut. May be referred to as the “work piece”.

Weld metal

The portion of the base metal that has been melted during welding.

Heat-affected zone (HAZ)

That portion of the base metal that has *not* been melted during welding, but whose mechanical properties and/or microstructure have been altered by the heat of welding or cutting.

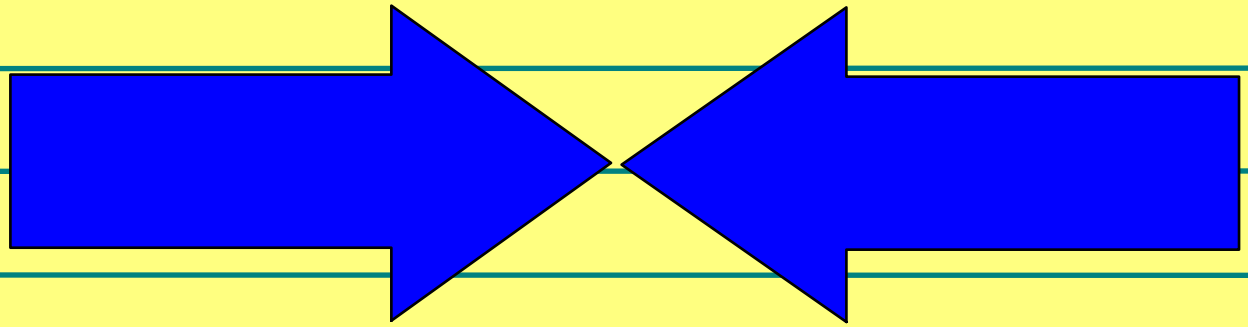
Joint

The junction of members or the edge of members that are to be joined.Usually beveled or otherwise designed for welding.

“V” Groove or “U” Groove

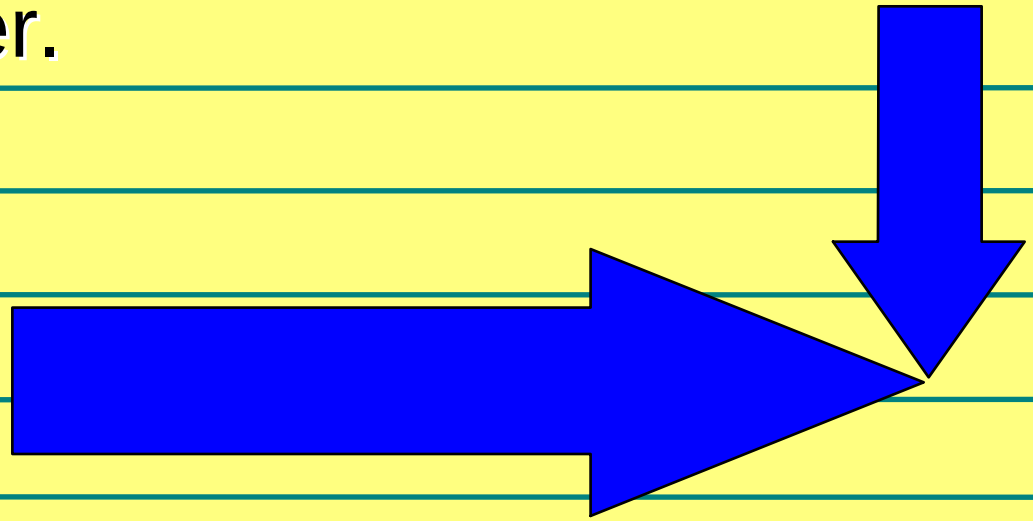
Butt weld (joint)

A joint between two members aligned approximately in the same plane.



Fillet weld

A weld of approximately triangular cross section joining two surfaces at approximately right angles to each other.



Welding electrode

A component of the welding circuit that terminates at the arc. May also be the source of filler metal.

Polarity

Manner in which the electrode holder and work piece connection are connected to the electrical supply.

-continued-

Polarity

- DCEN direct current electrode negative. (straight polarity)

- DCEP direct current electrode positive. (reverse polarity)

Welding position

- flat
- horizontal
- vertical
- overhead
  - fixed
  - rolled

Weld pass

A single progression of welding along the joint. The result of a pass is a weld bead.

Stringer (root) bead

The first pass in the weld, usually made without any appreciable weaving motion.

Hot pass

The weld pass that immediately follows the stringer (root) pass.

Filler passes

The weld passes that follow the hot pass and fill the weld groove flush or almost flush with the surface of the work pieces.

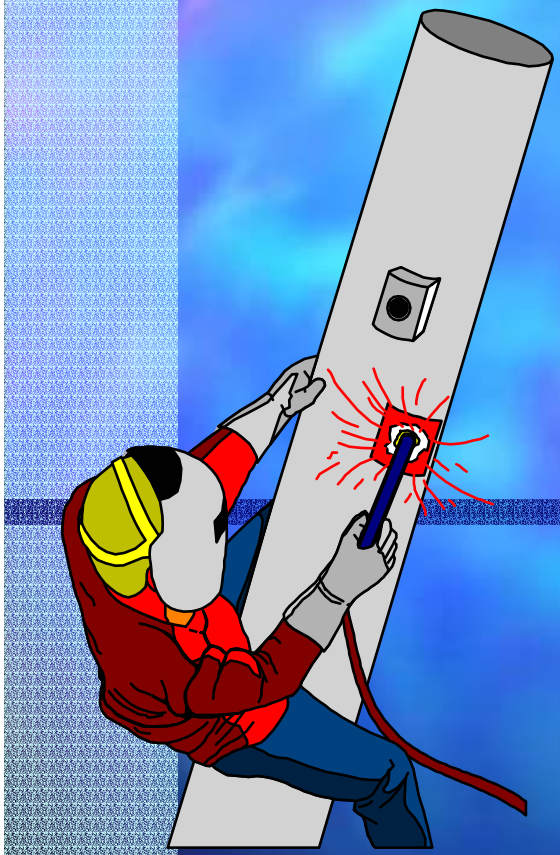
Cover pass

The weld pass that finishes the welded joint. The cover bead is higher than the adjacent surface and overlaps the groove.

Arc burn

A metallurgical notch, caused by ground clamps or from striking an arc on the base metal at any point other than:

- in the weld groove, or
- the immediate surface next to the groove that will be covered by the weld cap



Welding

Subpart "E"

Not applicable to welding
during manufacture
of pipe and components

§192.225 WELDING - GENERAL

- Performed by a Qualified Welder
- Using Qualified Welding Procedures
- Procedures Qualified by Destructive Testing

§192.225 WELDING - GENERAL

"Qualified Procedure" vs "Qualified Welder"

"qualified procedure test" verifies integrity/ metallurgy of that weld

"qualified welder test" verifies ability of that welder

§192.225 Welding procedures

- Welding Performed by Qualified Welder
- Welding Procedures Qualified Using API 1104 Section 5 or ASME B&PV Section IX
- Recorded in Detail and Destructively Tested
- Followed Whenever the Procedure is Used

Reference : API Standard 1104, 2.2

PROCEDURE SPECIFICATION NO._____

For _____ **Welding of** _____ **Pipe and Fittings**

Process _____

Material _____

Diameter_____ **Wall thickness** _____

Joint design _____

Filler metal_____ **Number of beads**_____

Electrical or flame characteristics_____

Position _____

Direction of welding _____

No. of welders _____

Time lapse between passes _____

Type and removal of lineup clamp_____

Cleaning and/or grinding_____

Preheat stress relief _____

Shielding gas and flow rate _____

Shielding flux _____

Speed of travel _____

Sketches and tabulations attached_____

Date tested_____ **Welder**_____
Date approved_____ **Welding supervisor**_____
Date adopted_____ **Chief engineer**_____

COUPON TEST REPORT

Date _____ Test No. _____
Location _____
State _____ Weld Positions Roll ☐ Fixed ☐
Welder _____ Mark _____
Welding time _____ Time of day _____
Welding temperature _____ Wind break used _____
Weather conditions _____
Voltage _____ Amperage _____
Welding machine type _____ Welding machine size _____
Filler metal _____
Reinforcement size _____
Pipe type and grade _____
Wall thickness _____ Outside diameter _____

	1	2	3	4	5	6	7
Coupon stenciled							
Original specimen dimensions							
Original specimen area							
Maximum load							
Tensile strength per square inch of plate area							
Fracture location							

☐ Procedure ☐ Qualifying test ☐ Qualified
☐ Welder ☐ Line test ☐ Disqualified

Maximum tensile _____ Minimum tensile _____ Average tensile _____

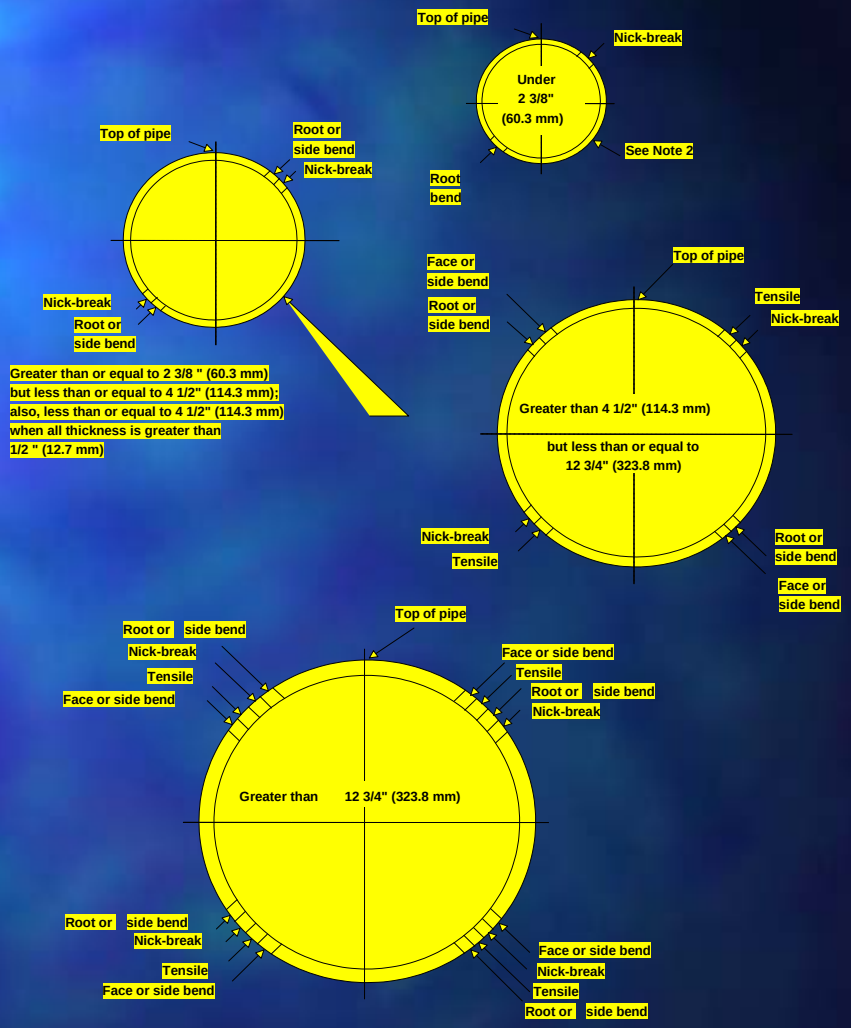
Remarks on tensile-strength tests
1. _____
2. _____
3. _____
4. _____

Remarks on bend tests
1.. _____
2. _____
3. _____
4. _____

Remarks on nick-break tests
1. _____
2. _____
3. _____
4. _____

Test made at _____ Date _____
Tested by _____ Supervised by _____

Note: Use back for addition remarks. This form can be used to report either a procedure qualification test or a welder test.



Notes:
1. At the company's option, the locations may be rotated, provided they are equally spaced around the pipe; however, specimens shall not include the longitudinal weld.
2. One full-section tensile-strength test specimen may be used for pipe with a diameter less than or equal to 1 5/16 inch (33.4 millimeters).

Essential Variables - API 1104 Proc. Qual.

- Change in Process or Method of Application
- Pipe Grades
  - <= 42,000 SMYS
  - > 42,000 but < 65,000
  - > 65,000 - Separate Test for Each Grade

Essential Variables - API 1104 Proc. Qual.

- Joint Design (U or V groove)
- Position (fixed or rolled, horizontal or tilted)
- Wall Thickness Group
  - < 3/16” (.1875)
  - 3/16” - 3/4” (.1875 - .750)
  - > 3/4” (.750)

Essential Variables - API 1104 Proc. Qual.

- Time Between Passes
  - Max time between root and second
- Direction of welding
  - Uphill or downhill

Essential Variables - API 1104 Proc. Qual.

- Shielding Gas and Flow Rate
- Shielding Flux
- Speed of Travel
- Filler Metal Group

Group	AWS Specification	Electrode
1	A5.1 A5.5	E6010 E6011 E7010 E7011
2	A5.5	E8010 E8011
3	A5.1 or A5.5 A5.5	E7015 E7016 E7018 E8015 E8016 E8018

§192.227 Qualification of Welders

- Section 6 of API Standard 1104
- Section IX of ASME Boiler and Pressure Vessel Code
- Less than 20% SMYS - Appendix C

§192.227 Qualification of Welders

- Welder Qualified under Earlier Edition of API 1104 or ASME Section IX---
  - May Continue to Weld
  - May Not Requalify under that Edition

Qualified Welders

- *Must* have funny looking hats
- *Must* have helpers
- *Must* have BBQ grills

API 1104 - Welder Single Qualification (Butt or Fillet)

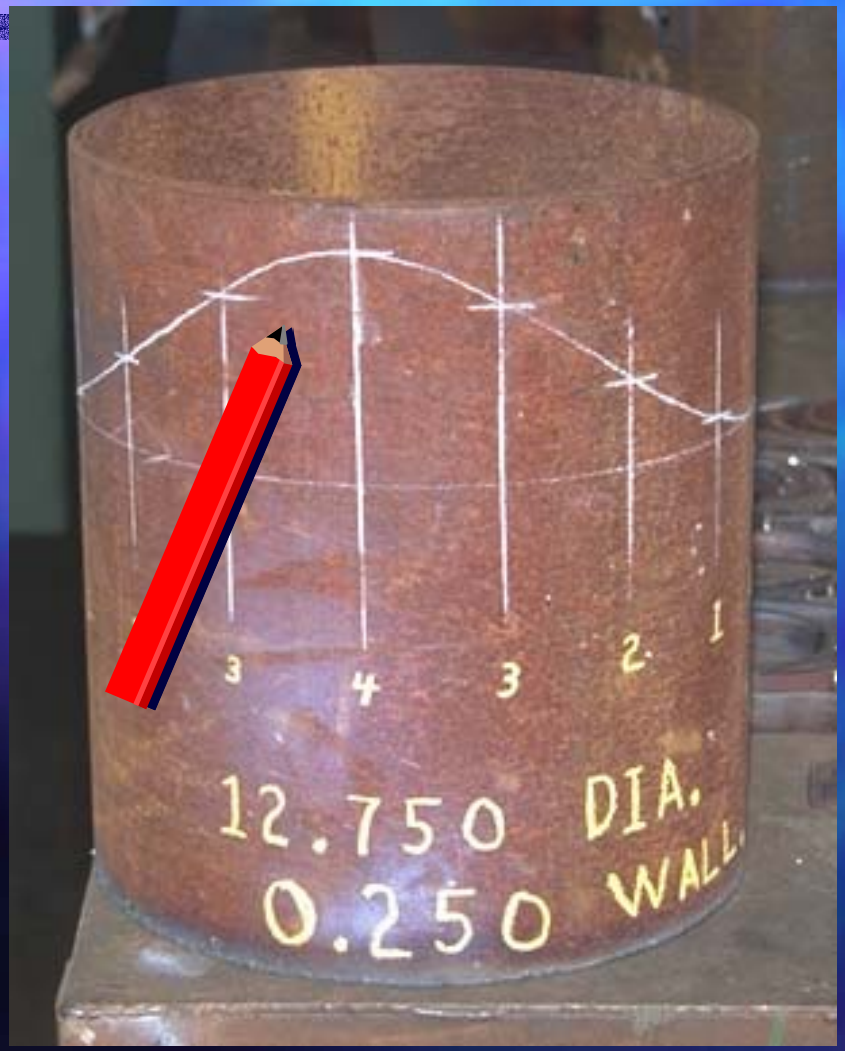
- If Qualified on Butt Welds in Fixed Position @ 45° Angle, Qualified for Butt Welds and Lap Fillet Welds in all Positions

Essential Variables - Welder Single Qualification

Change in any one of:

- Process
- Direction of Welding
- Filler-metal Classification
- Outside Diameter Group
- Wall Thickness Group
- Position
- Joint Design

API 1104 - Welder Multiple Qualification



- Must Make Butt Weld
- Layout, Cut & Fit Branch Connection
- Cut Hole in Run for Branch
- Make Fillet Weld on Branch/Run Joint

API 1104 - Welder Multiple Qualification

- Butt Weld Must Be Made on Pipe at Least 6.625” (12.75" qualifies for all dias.)
- Branch Must Be of Pipe at Least 6.625”
- Butt Weld Made in Fixed Horizontal or 45° Angle Position

API 1104 - Welder Multiple Qualification

- Cut Full-Size Hole in Run Pipe
- Run Pipe Shall Be Horizontal
- Branch Shall Extend Vertically Downward From Run Pipe

Essential Variables - Welder Multiple Qualification

- Change in welding processes
- Change in direction of welding
- Change in filler metal classifications

§192.229 Limitations on Welders

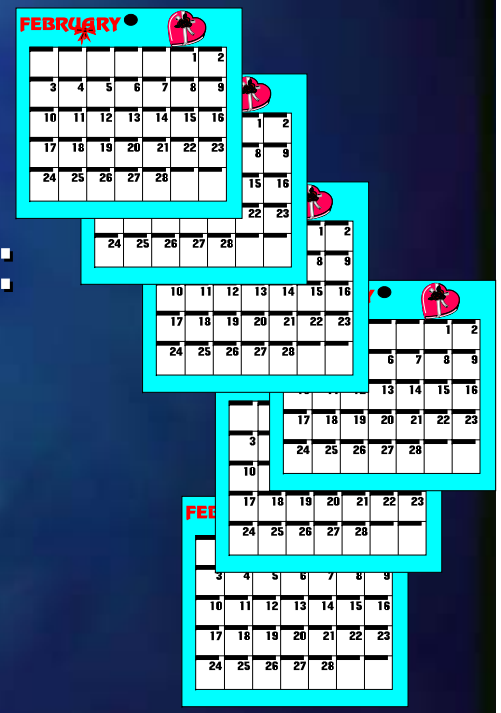
- Welder whose qualification is based on nondestructive testing may not weld on compressor station pipe and components
- Must weld in particular process within every 6 calendar months

192.229 ~ Additional Limitations

- Welder qualified under Section 6 of API 1104 or Section IX of ASME

To weld on pipe operating at 20% SMYS or more, must have weld tested:

- Every 6 months per API 1104 Section 6 or 9, or
- Twice each CY at intervals Not exceeding 7-1/2 months

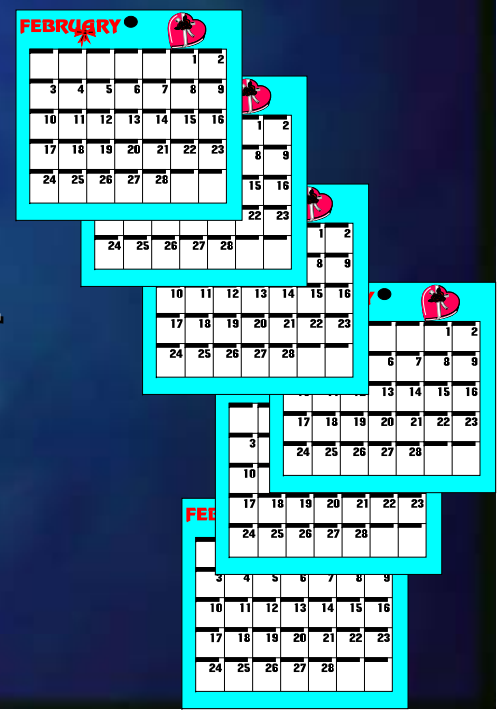


§192.229 ~ Additional Limitations

- Welder qualified under Section 3 of API 1104 or Section IX of ASME

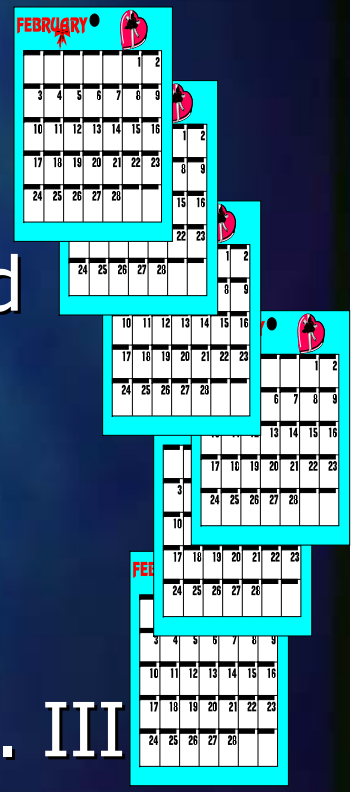
To weld on pipe operating < 20 % SMYS, must:

- Have weld tested every 6 months per API 1104 Section 6 or 9, or
- Requalify under Appendix C every calendar year n.t.e. 15 months, or
- Cut out and test a production weld twice each calendar year



§192.229 ~ Additional Limitations

- Welder qualified under Appendix C
  - Must requalify under Appendix C every calendar year n.t.e. 15 months, or
  - Must cut out and test a production weld twice each calendar year (interval cannot exceed 7 1/2 months), or
  - For service lines 2 inches and smaller only, 2 welds tested per App. C, Sec. III



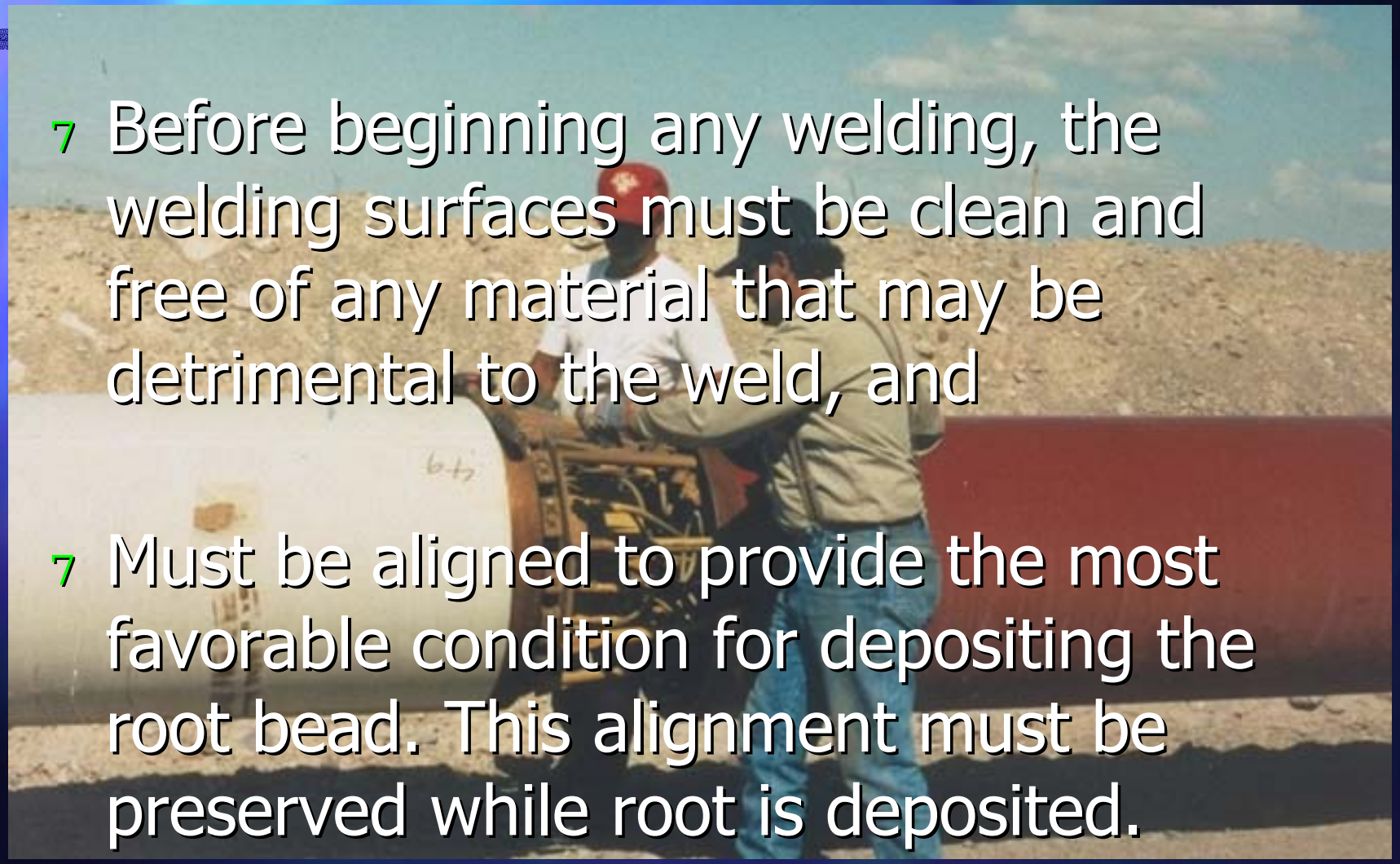
§192.231 Protection from Weather

- The welding operation must be protected from weather conditions that would impair the quality of the completed weld.

§192.233 Miter Joints

- 30% or more SMYS, Maximum of 3°
- 10%<SMYS<30%, Maximum of $12^{1/2}$° Must be one diameter from any other miter
- 10% or less SMYS, Maximum of 90°

§192.235 Preparation for Welding



- Before beginning any welding, the welding surfaces must be clean and free of any material that may be detrimental to the weld, and
- Must be aligned to provide the most favorable condition for depositing the root bead. This alignment must be preserved while root is deposited.

§192.241 Inspection and Test of Welds

- Visual inspection (by individual qualified by training & experience) of the WELDING must be done to insure --
  - Welding is done according to procedure, and
  - Weld is acceptable per API 1104 Section 9.

§192.241 Inspection and Test of Welds

- Welds on pipelines operating ≥ 20% SMYS must be NDT'd, except:
  - Welds visually inspected and OK'ed by a qualified welding inspector if:
  - Pipe is < 6" nom. dia.; or
  - Line operates below 40% SMYS and welds are limited in number.

§192.243 Nondestructive Testing

- NDT must be performed by any process, other than trepanning, which will clearly indicate defects that may affect the integrity of the weld.

§192.243 ~ What is Trepanning?

§192.243 Nondestructive Testing

- NDT must be performed:
  - In accordance with written procedures; and
  - By persons trained and qualified in the procedures and with the equipment being utilized

§192.243 Nondestructive Testing

- Procedures must be established for interpretation of each test to ensure acceptability of the weld per API 1104 Section 6.

§192.243 Nondestructive Testing

- When required, random testing of each days welds must be tested at the following rates;
  - Class 1 areas - 10%
  - Class 2 areas - 15%
  - Class 3 & 4, offshore, rights-of-way - 100%, unless impracticable, then 90%
  - Tie-Ins (including replacement sections)

§192.243 Nondestructive Testing

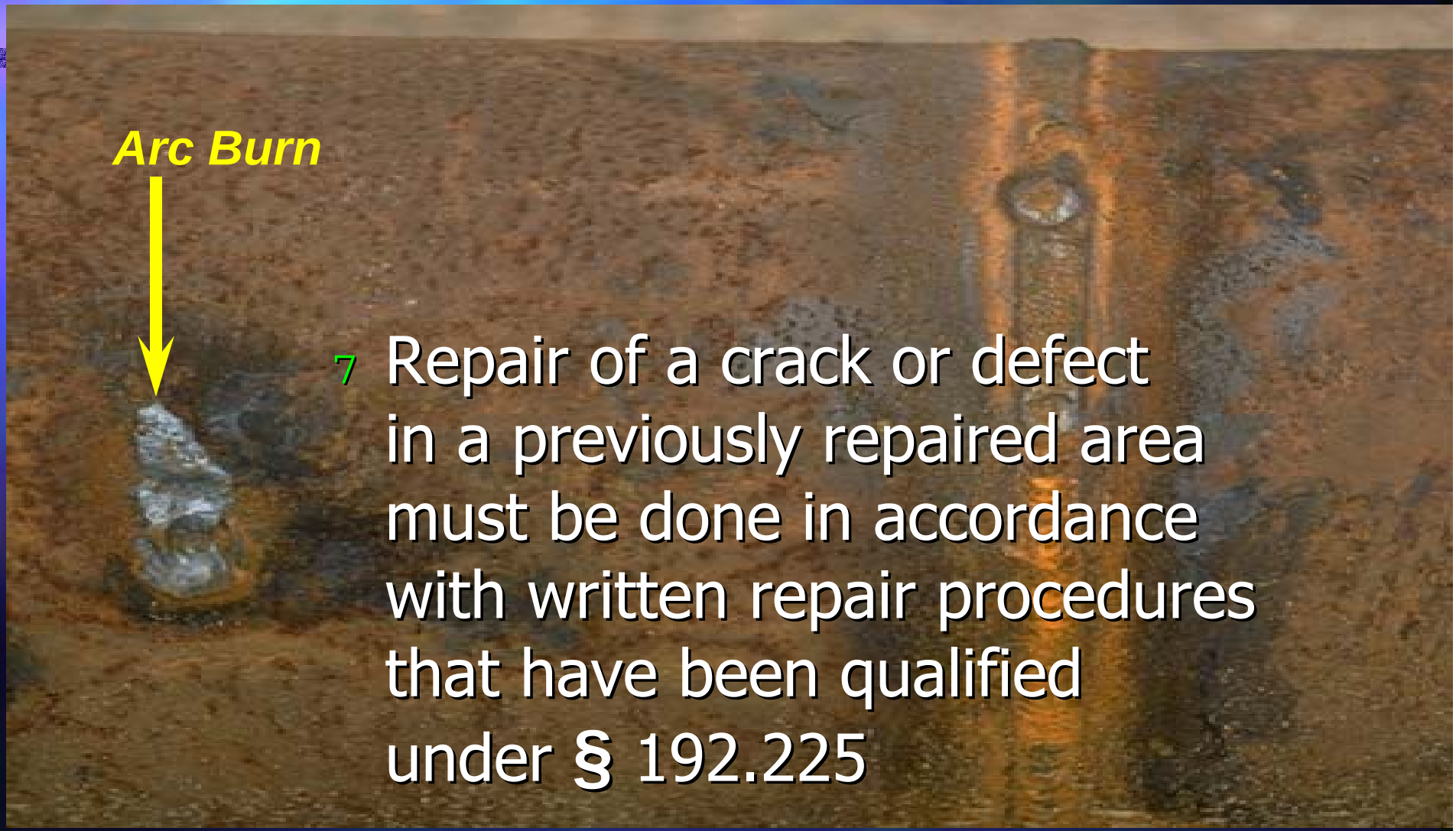
- Must test some of each welders work each day
- Must retain for life;
  - Record by milepost, engineering station, etc.;
    - **Number of welds**
    - **Number tested**
    - **Number rejected**
    - **Disposition of rejects**

§192.245 Repair or Removal of Defects

- Each unacceptable weld under.241(c);
  - Must be removed or repaired
  - Removed if crack is >8% of weld length

- For repairs, must remove defect down to sound metal, pre-heat if necessary, and re-inspect.

§192.245 Repair or Removal of Defects



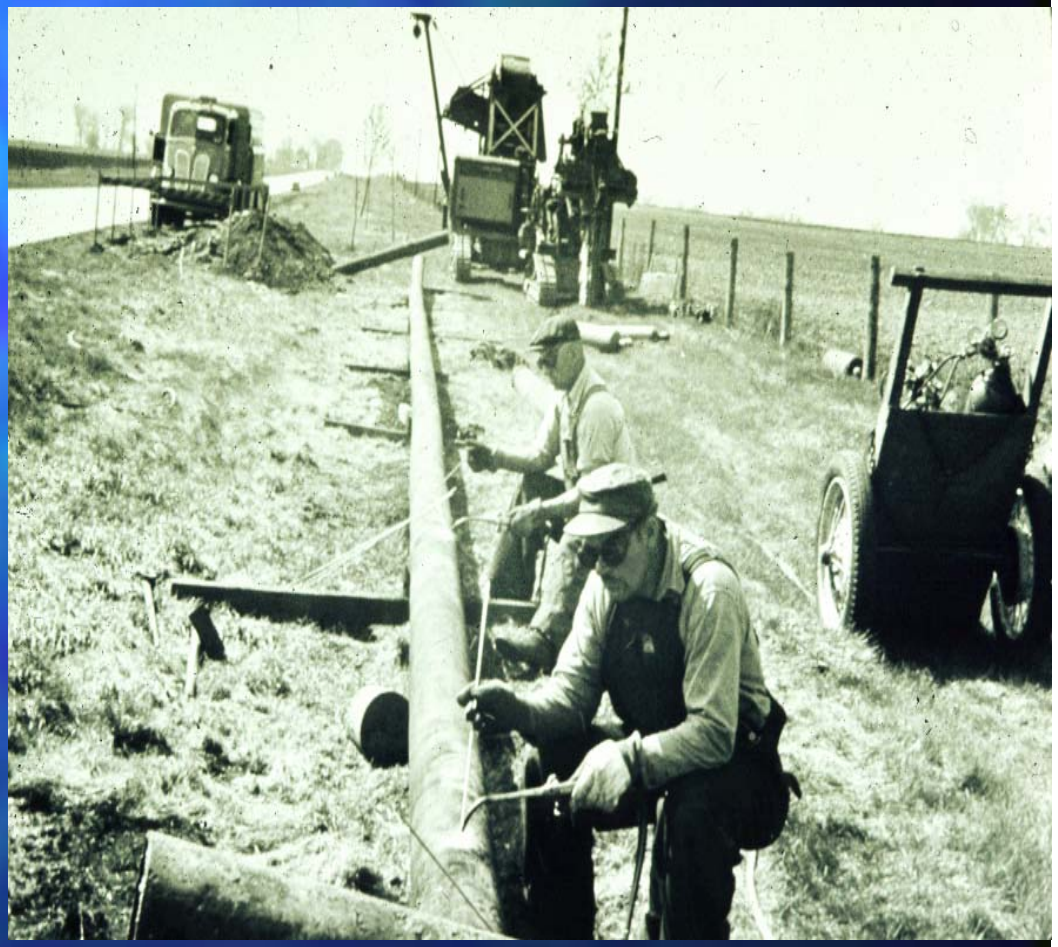
- Repair of a crack or defect in a previously repaired area must be done in accordance with written repair procedures that have been qualified under § 192.225

§192.309 Repair of Steel Pipe

- (c) Each arc burn on steel pipe to be operated ≥ 40% SMYS must be repaired or removed. If repaired by grinding, must check remaining w.t. ….
- Use dilute solution of ammonium persulfate to check

Appendix "C" Basic Test

- Test on pipe 12" or smaller
- Weld in horizontal, fixed position
- Weld according to a qualified, written procedure



Appendix "C" Basic Test

- Cut weld into four coupons
- Subject to a root bend test
- If two or more have a crack >1/8", weld is unacceptable
- Successful test qualifies welder to weld on pipe diameters ≤ 12 inches

Appendix "C"
Service Connections To Mains

- Weld service connection to pipe of typical main size in same position as in field
- Test destructively

Appendix "C" Small Service Lines

- Two samples 8" long are cut w/ weld in center
- Subject one to guided bend test
- Subject second to tensile test
  - If tensile machine not available, bend

What should state/federal inspectors or operators check for compliance regarding Subpart E?

- Written welding procedures with qualifying test results available
- How welders are qualified (API, ASME, Appendix C)
- Verification of use of qualified welders
- How welders maintain qualification/ re-qualify
- Qualifications of welding inspectors

What should state/federal inspectors or operators check for compliance regarding Subpart E?

- Adherence to welding procedures/
  code requirements/housekeeping during field welding
- Use of N.D.T. / qualifications of N.D.T. technicians
- Special procedures for "hot" or repair welding
- Repair criteria for defective welds
- Maintenance of required records